THE GRAND RIVER

AND

POLLUTION

1957 to 1963

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Chapter I - INTRODUCTION

1. OWRC Stream Sanitation Policy

Stream pollution control is one of the prime concerns of the Ontario Water Resources Commission. Control of pollution requires the location of polluting sources and the elimination or treatment of offending discharges. Stream surveys and municipal pollution investigations have been performed on all major streams and in most municipalities since the inception of the Commission in 1957. In order to reduce the effect of polluting materials on water resources, efforts have been concentrated on providing adequate treatment for municipal wastes.

2. The Grand River Water Resource

The Grand River presents a particularly difficult sanitary engineering problem. The River is utilized for a variety of purposes by the particularly dense basin population. Water supply is obtained from the river by the City of Brantford and the Village of Cayuga in the lower reaches. All the municipalities in the watershed have no alternative but to discharge domestic and trade wastes to the stream. As well, the stream is used for extensive recreational activities.

Because of the need to protect many of the established uses, it is apparent that a comprehensive study of the river's capacity for self purification is required. Revisions of the water quality monitoring program are suggested.

Stream survey results are compared with the present objectives for water quality considered to be indicative of conditions which do not unduly compromise the reasonable use of the stream. Modern sewage treatment requires dilution of the effluent to complete the purification process. Unfortunately the ability of the stream to perform this function has not been determined. This capacity must be known if the stream is to be used to its fullest extent without the development of adverse conditions.

3. Scope of the Report

The aims of this report are multiple and include:

(a) an outline of the pollution abatement measures applied to date;

(b) a review of the Grand River water quality as indicated by past surveys;

(c) an appraisal of the reliability of the sampling data;

(d) a suggested revision of the water quality monitoring program on the Grand River; and

(e) a recommendation that concentrated waste assimilation studies below the major population centres of Kitchener, Guelph and Brantford are necessary.

Chapter II - SUMMARY AND RECOMMENDATIONS

1. Summary

(a) The current pollution abatement program of the OWRC to provide secondary sewage treatment for each municipality on the Grand River has progressed rapidly. Of the 22 cities, towns, and villages situated along the Grand River and its tributaries 12 have some form of sewage treatment. This includes approximately 95 per cent of the urban population of the drainage area. Sewage treatment is inadequate in Bridgeport, Elora, Elmira, Dundalk, Baden, Ayr, Cayuga, Dunnville, Waterloo and Hespeler.

Significant amounts of inadequately treated industrial wastes are discharged at 46 locations along the river and its tributaries. Gradually these industrial waste problems are being resolved either by connections to municipal sewerage systems, or by provision of treatment works at the industrial sites. The most pressing problems arise from the following industries.

Canada Glue Company Ltd.	-	Brantford
Atlas Powder Company Ltd.	-	Brantford
Dominion Woolens and Worsted	-	Hespeler
Artex Woolens	-	"
Stamped and Enamelled Ware	-	"
Gordon Young Ltd.	-	Elmira
Naugatuck Chemical Co.	-	"
Electric Reduction Company Ltd.	-	Sherbrooke
Best Foods	-	N. Dumfries

Protection of municipal sewerage facilities from harmful wastes is required. Although sewers and pumping equipment can be seriously affected, the most vulnerable part of the sewerage system is the treatment process itself.

The discharge of various types of industrial wastes often causes damage to the sewer systems and interferes with the biological treatment processes. Comprehensive sewer use by-laws to control these types of flows are lacking in most of the municipalities.

The extreme fluctuations of stream flows experienced prior to 1942 have been diminished by the construction of the Shand, Luther, and Conestoga dams. Low-flow studies using the gauge records at Galt have indicated that the 20-year return period low flows which can be sustained by the 100,000 acre feet of conservation storage presently available provide

adequate dilution. As sewage flows increase, additional conservation storage will be required.

(b) Sampling surveys have indicated that satisfactory stream conditions exist upstream from Bridgeport. In general the water quality of the major tributaries has been satisfactory.

Pollution is evident in the following river reaches:

(i) Speed River - from Guelph to the confluence with the Grand River.

(ii) Grand River - extending 20 miles downstream from Bridgeport.

(iii) Grand River - from Brantford downstream for approximately 20 miles.

These reaches receive the greatest pollution loading from the major population concentrations. Increases in B.O.D. concentrations and coliform densities are noticeable downstream from most of the municipalities but recovery is rapid with the exception of the above reaches.

Extremely degraded conditions exist in Canagagigue Creek downstream from Elmira. Domestic and trade wastes discharged without treatment from the Town of Dunnville have created objectionable conditions in Sunfish Creek and along the east side of the Grand River downstream from the town.

(c) Previous sampling surveys provided valuable qualitative appraisals of stream conditions. The statistical value of the grab sample survey was compromised because the surveys could not provide a continuous record.

(d) Improvements in the water quality monitoring program are suggested. Fewer points and more frequent sampling at significant points is indicated. Any noticeable impairment would be followed up by more intense surveys.

The value of municipal pollution surveys is indicated. These should be repeated as required.

(e) As population increases, the river will be required to accept greater deoxygenating loads from sewage treatment facilities. To assess the ability of the stream to accept

these increased loads, more intense studies should be carried out below the Kitchener, Guelph, and Brantford areas. Determination of the dissolved oxygen assets, deoxygenation rates, re-aeration rates, should be carried out in these critical river reaches. In conjunction with this work, biological investigations would be necessary. When the results of these surveys are available it would then be possible to estimate the degree of treatment consistent with acceptable stream conditions. As well, planning for the locations of future sewage works would be facilitated.

The ability of the Grand River to accept future waste loadings could be used as a guide in planning future urban developments. Municipalities should be urged to cooperate in joint undertakings for water supply and waste disposal particularly in the major growth areas.

(f) Considering the use of the Grand River for waste water dilution, further development for water supply would require extensive evaluations of the associated engineering and economic problems.

2. Recommendations

1. Sewage treatment plants should be constructed to serve, Dundalk, Elora, Elmira, Baden, Ayr, Cayuga and Dunnville.

2. Improved sewage treatment is required at Hespeler and Waterloo.

3. The discharge of inadequately treated industrial waste to the Grand River should be curtailed.

4. Industrial-waste or sewer-use by-laws should be enacted by municipalities to protect the facilities from adverse trade waste discharges.

5. Detailed engineering and biological studies to evaluate the ability of the Grand River to assimilate wastes should be carried out in the following river reaches:

   (a) Bridgeport Bridge to Glen Morris
   (b) Speed River upstream from Guelph to the confluence with the Grand River
   (c) Paris dam to Caledonia

6. The conservation storage reservoir construction program should be accelerated to provide the maximum practical storage upstream from Kitchener.

7. The OWRC water quality monitoring program should be revised to include a continuous record of conditions at key points.

   The suggested points, already established, on the Grand River are:

1.	G-110.3	Bridgeport bridge
2.	G-94.3	Blair at bridge
3.	G-86.5	Riverside bridge
4.	G-82.8	Glen Morris dam
5.	G-54.5	Cainsville
6.	G-0.4	Port Maitland upstream from the influence of Lake Erie
7.	GSP-96.9	Speed River at Beaverdale bridge

Chapter III - WATERSHED DESCRIPTION

1. Physical Description

The Grand River rises in the neighbourhood of Dundalk, approximately 22 miles from Georgian Bay, and flows 182 miles to its mouth at Port Maitland on Lake Erie. The drainage basin is situated in the central portion of the Southern Ontario peninsula which is bounded on the north by Georgian Bay, on the south by Lake Erie, on the east by Lake Ontario and on the west by Lake Huron. It includes nearly the whole of the counties of Waterloo, Wellington, Brant and parts of Dufferin, Grey, Haldimand, Perth, Wentworth, Norfolk, Oxford and Halton. The 118 mile long drainage basin occupies some 2,614 square miles and has an average width of 22 miles. (Figure 1 Appendix)

The principle tributaries of the Grand River are the Conestoga, Speed, Eramosa and Nith rivers. The Boston, McKenzie, Fairchild, Whiteman, Big and Canagagigue creeks drain significant areas, but for the most part the population is centered around the main stream and the major tributaries.

The river rises at an elevation of 1,700 feet above sea level and flows to its mouth at an elevation of 572 feet. The total fall is 1,128 feet for an average gradient of 6.2 feet per mile. Considerably higher gradients exist on the Speed, Eramosa and Conestoga rivers.

Details of the drainage areas are outlined in Table 1, Appendix.

(a) Physiography

Generally, the physiography of the watershed is formed by a gently rolling or slightly undulating country traversed in parts by gravel ridges and hills. Three distinct topographical regions may be recognized.

The Plains of the Lower Grand consist of a relatively level sand and clay plain extending from Lake Erie to a few miles north of Brantford and comprise one fifth of the total watershed area. Limestone bedrock outcrops in Beverly Township.

The Central Hilly Belt is the major area occupying

48 per cent of the watershed. This region extends north from Brantford and is composed of morainal hills, drumlins and gravel ridges which create a rolling and undulating countryside.

The Flat Northern Plains in the headwaters (approximately 30 per cent of the total area) begin in a high plateau - like area commencing in the neighbourhood of Dundalk. This fairly level expanse of land generally sloping to the south contains large areas of poorly drained swamp land, eg. Luther Marsh. A combination of the high snowfall in this area, the impermeable soil and the density of artificially constructed drainage channels in the region, contributes to the particularly high flood crests experienced during the spring runoff months.

(b) Geology and Soils

In most areas the bedrock is covered over by almost 100 feet of overburden. However, the rock outcrops in several locations along the main river (Fergus to Elora) and the Speed and Eramosa rivers. Two main rock classifications underly the basin:

(a) Guelph dolomite to the east
(b) Salina, Bass Island and Bois Blanc formations of dolomite limestone and shale to the west.

Roughly paralleling the line of intersection of the two rock interfaces (Figure 2) the Guelph soil series lies to the south and east of the watershed. This soil with its deeper layers of sand gravel provides excellent drainage, increasing deep seepage, and helping to maintain stream flows experienced during the summer months. To the north and west, mainly in the headwaters region, the highly impermeable London clay series predominates. Particularly high runoff rates from this soil area (heavy clay-loam and clay subsoils) increase high spring flood crests. In the plains of the lower Grand the heavy Haldimand clay belt predominates.

(c) Precipitation and Temperature

The average total precipitation on the drainage area is approximately 33 inches, varying only slightly throughout the basin. A significant portion of the precipitation consists of snowfall which varies from a minimum of 45 inches annually at Brantford, to 60 inches along Lake Erie, and 90 inches in a north westerly direction at Mount Forest.

Similar to most of southern Ontario, the average temperature over the total basin is 40 degrees Fahrenheit, with the average winter temperature varying from 29 degrees at Lake Erie to 23 degrees in the headwaters.

The combination of high snowfall in the Northern Plains region and low winter temperatures provides an abundance of snow remaining on the ground surface in the springtime. A quick uniform rise in temperature during the spring results in rapid snow melt which runs off the impermeable soil on a steep gradient thereby producing high downstream flood crests.

2. Municipalities and Population

Five cities, seven towns and eleven villages are situated along the banks of the Grand River and its tributaries. In effect, the majority of the population is concentrated in two main areas i.e. the Kitchener-Waterloo area and the Brantford area. The Kitchener-Waterloo area includes, Bridgeport, Elmira, Galt, Preston, Hespeler and Guelph, embracing a triangular shaped area of approximately 114 square miles. The Brantford area consists of the municipalities of Brantford and Paris. In these two areas the majority of the population and the industrial and commercial activities are centred.

Presently, the total population of the Grand Valley is approximately 363,000 persons, of which 269,000 or 74 per cent may be classed as urban i.e. living in the twenty-three incorporated municipalities. Fifty-two per cent of the total population, or 189,295 persons live in the vicinity of Kitchener-Waterloo and the Brantford area supports some 60,000 persons.

Graphical extension of the present populations at the current growth rate of 3.0 per cent per year indicates that the drainage area will support in excess of 680,000 persons by the year 2000 of which seventy-eight per cent or 530,000 persons will be urban. At the present rate of increase, the Kitchener-Waterloo area alone will contain 400,000 persons. The extended populations to the year 2000 are included in Table 2 and illustrated in Figure 3, A-B Appendix.

The locations of municipalities are shown in Figure 1.

3. Character of Stream Flow

Prior to the construction of conservation storage reservoirs, the Grand River was subject to high snow melt run-off floods and to periods of extremely low flows during the summer. Damaging floods occurred during the spring and obnoxious conditions developed from discharge of wastes during low flow periods. High snowfall in the upper watershed, in conjunction with impermeable soil conditions, steep gradients and the lack of natural storage, resulted in the spring floods. Particularly low flows are typical of streams lacking natural storage reservoirs.

The range in flow conditions is indicated by the summarized flow records for the gauge at Galt shown in Table 3. Considerable improvement in the low flow conditions can be seen after 1942 subsequent to the commencement of operation of the Shand dam, and later the Luther and Conestoga dams.

The Department of Northern Affairs and National Resources maintains thirteen gauging stations on the Grand River and its tributaries. Table 4 summarizes the location and period of record provided by each. The most significant records are obtainable from the Galt gauge which has been recording continuously from 1913.

Chapter IV - POLLUTION ABATEMENT PROGRAM

Most municipalities have no alternative but to discharge sanitary and trade wastes to the stream. Two definite programs are being implemented to improve stream conditions. First, the municipalities of Brantford, Kitchener, Galt, Waterloo, Preston, Paris, Fergus and Elora, members of the Grand River Conservation Commission, have been carrying out conservation and flood control storage schemes. Secondly, the Ontario Water Resources Commission has initiated sewerage projects in co-operation with the Grand River municipalities to eliminate major sources of pollution.

1. Sewage Treatment Plant Construction

Financed by the OWRC, at a total expenditure of approximately $10 million, sewage works and extensions have been constructed at Brantford, Paris, Fergus, Waterloo-Kitchener, Galt, Preston, Arthur and New Hamburg. Projects are in various stages of development at Elora and Elmira. The Towns of Dunnville and Hespeler have been approached to solve their sewage disposal problems along with the Village of Bridgeport and the Hamlet of Baden. Of the 22 cities, towns and villages situated along the river and its tributaries, a total of 12 municipalities have some form of sewage treatment. This would include approximately 95 per cent of the urban population of the drainage area.

The status of sewage treatment in each of the urban municipalities is summarized in Table 5. At the present time, 9 municipalities provide treatment of a secondary nature or the equivalent. Two plants are in the design stage. Improved treatment is required at the City of Waterloo. The Town of Dunnville and the Villages of Dundalk, Ayr and Cayuga should construct sewerage works. The Town of Hespeler should provide improved treatment for domestic sewage and planning should include the abatement of industrial waste pollution.

2. Industrial Wastes

Varied light industries have grown up in the Grand Valley. Operations vary from the processing of agricultural products (slaughterhouses, milk plants, canneries) to light manufacturing and chemical industries, electro-plating, sulphuric acid production, etc. In most cases the trade wastes have been accepted into the municipal sewer system

However, significant quantities of contaminating wastes are discharged to the stream from the industries mentioned in Table 6.

In Kitchener and Waterloo industrial wastes are accepted into the municipal sewerage system. Complications have developed at the Waterloo plant due to fluctuating pH conditions and excessive organic loadings. The need for industrial waste by-laws is indicated.

In the majority of cases correction of the industrial waste pollution could be made by accepting pre-treated trade wastes into the municipal system in accordance with a comprehensive sewer use by-law. Where municipal facilities are not available, or not capable of handling the industrial loading, the industry should be obliged to construct treatment works.

3. Flow Regulation

In 1938, the Grand River Conservation Act was passed creating the Grand River Conservation Commission. This organization was charged with the regulation of floods and conservation of public water supplies. To compensate for the lack of natural storage in the headwater region, three dams were constructed:

(a) Shand Dam - 1942
(b) Luther Dam - 1953
(c) Conestoga Dam - 1959

Primarily, designed for flood protection, the augmentation of low flows during the summer period was a second purpose.

It was planned to construct a total of 200,000 acre feet of storage upstream from Brantford. Presently, the storage capacity of the three dams approximates 100,000 acre feet.

With population increases, flood control will remain important, but augmentation of stream flow during drought will become increasingly necessary as waste flows increase. The reservoir construction programme was intended to provide an average of 350 cfs at Galt and 500 cfs at Brantford. To meet flood control and flow maintenance requirements, two more dams will be designed shortly, i.e. the Montrose reservoir on the Grand River and the Ayr reservoir on the Nith River. Table 7 summarizes the dam projects anticipated.

(a) Drought Flow Study

The gauge at Galt provides a substantial period of record for hydrological computations - (1913-1963). In addition, it is situated immediately below the critical Kitchener-Waterloo area where the greatest organic load is placed on the stream. Periods of 245 days and 273 days during which outflow from the reservoirs is necessary to augment stream flow, were considered. The average flows occurring during these periods were plotted graphically on log probability paper, and the flows with 5, 10 and 20 year return periods were determined as shown in Figures 4 A-B and Table 8 and 9.

Considering a 20 year return period, the average daily flow which could be sustained by storage of 100,000 acre feet would be 365 cfs. Without increased storage, it is anticipated that sewage flows from the growing population will exceed the dilution capacity of the stream by the year 1975.

During a dry period the actual stream flow could fall well below the average predicted 20 year return period low flow, and stream degradation could be expected.

Although the average daily flow over the cited low flow periods has been successfully retained above the 350 cfs level since 1942, daily flows have registered as low as 88 cfs.

Chapter V - PREVIOUS POLLUTION SURVEYS

1. Description

Complete sampling surveys of the Grand River and tributary streams were performed on May 8, 1957, June 19, 1958, July 14, 1959, July 19, 1960, April 19, 1961, August 9, 1961, October 10, 1962 and February 15, 1963. Reports were written in 1958, 1959 and 1960. Results are also on record of partial sampling runs carried out on other dates.

(a) Purpose

The purpose of the investigations was to locate sources of pollution along the river and to assess the effect of polluting materials on the stream. The degree of pollution was also estimated according to the OWRC objectives for water quality.

(b) Procedure

Stream sampling locations were selected along the length of the stream upstream and downstream from each municipality, or suspected source of pollution, and at the junctions of tributary streams. The locations were designated by a letter referring to the stream and by numbers showing the mileage in tenths of miles from the mouth of the river. Some 186 sampling points established at bridges or dams have been used.

Grab samples for coliform examinations and sanitary chemical analyses (B.O.D., turbidity, total solids) were obtained. Nitrate, nitrite and total Kjeldahl determinations were infrequently obtained.

(c) Use of Data

In reporting, the qualitative data obtained from the surveys was compared with the following objectives:

Item	Concentration
5-Day B.O.D.	4.0 ppm
M.F. Coliform Count	2,400 organisms per 100 ml.

Item	Concentration
Phenol	average 2 ppb maximum 5 ppb
pH	6.7 to 8.5
Iron	0.3 ppm

Experience has indicated that offensive conditions are not created if these objectives are maintained. The pH criterion applies for the well buffered Southern Ontario streams. In Northern Ontario much lower natural pH's are experienced.

2. Discussion of Survey Results

Table 10 and Table 11 of the appendix, list the 5-day B.O.D. and coliform counts at each sampling location for the more complete surveys, excluding the October 1963 survey. This latest series is treated separately in the Appendix.

(a) 5-Day B.O.D. Values

The 5-day B.O.D. in the upper reaches, from the headwaters to a point 70 miles downstream at Bridgeport, is generally satisfactory. In 1960, the B.O.D. below Fergus was 5.2, but following the installation of the OWRC sewage plant the B.O.D. level has been satisfactory.

The greatest organic loading occurs in the Kitchener - Waterloo area where in the past, B.O.D. values have exceeded the objective. The stream requires some 30 miles to recover and it resumes normal B.O.D. levels in the neighbourhood of Glen Morris.

Pollution from the Town of Paris and industrial operations in the Brantford area again raise the B.O.D. to excessive levels. Degradation lasts for some 30 miles downstream before more favourable conditions resume. During 1961 and 1962 a significant rise in B.O.D. was noted below Dunnville (Sunfish Creek), which was particularly noticeable considering the greater volume of flow near the river mouth.

Along the tributary streams i.e. Nith, Conestoga, Speed, etc. high B.O.D. levels are encountered below most communities, but recovery is rapid. For the most part, with the exception of the Speed River downstream from Guelph and

Hespeler, B.O.D. levels in these tributaries have been satisfactory. Excessive B.O.D. concentrations are common downstream from Elmira on the Canagagigue Creek.

It is interesting to note the high B.O.D. levels determined under the ice during the 1963 survey.

(b) Bacteriological Examinations

In the headwaters region the coliform densities are satisfactory. Commencing below the Fergus sewage plant outfall, coliforms increase above the objectives.

However, the death rate of bacteria is rapid, and improved conditions develop a short distance downstream. A rapid rise in coliforms is noted below each municipality along the river and usually exceeds the objective level.

Year round chlorination of sewage effluents would reduce the excessive bacterial populations to more tolerable levels. Continuous chlorination of the effluents at all OWRC plants other than lagoon systems commenced on a year round basis during 1963.

3. Summary

A definite trend in sanitary conditions cannot be established from the past stream investigations. This is not surprising since the major treatment improvements have only recently commenced operation.

Data derived from the stream surveys has provided a limited appraisal of water quality. The effective appraisal of water quality has been compromised because of infrequent samplings and limited analysis.

Satisfactory stream conditions exist upstream from the Bridgeport bridge along the main Grand River. The major tributaries generally exhibit satisfactory conditions with the exception of that portion of the Speed River downstream from Guelph to the confluence with the Grand River.

The discharge of industrial wastes and municipal sewage effluents periodically creates degraded conditions for some 30 miles downstream of both the Kitchener-Waterloo and the Brantford areas.

Adverse conditions were particularly noticeable downstream from the Towns of Hespeler, Elmira and Dunnville.

Pollution is attributed to the discharge of both domestic sewage and trade wastes from these municipalities.

Chapter VI - REVISED STREAM SURVEYS

1. Waste Assimilation Studies

Installation of secondary sewage treatment facilities in each municipality along the Grand River will result in considerable improvement in the river. Treatment of industrial waste discharges will similarly provide improvement. However, even after sewage treatment a residual content of polluting materials remains which must be assimilated by the stream. As the population of the Grand River drainage area increases the amount of residual pollution will correspondingly increase. It is probable that the amount of organic material added to the stream at critical points will produce undesirable conditions.

Since the current sewage treatment plant construction program is approaching completion, more emphasis should be placed on evaluating the ability of the Grand River to accept waste loadings. Once the amount of B.O.D. which can be accepted safely at any one point is determined and the distance downstream required for recovery is estimated, the location of future treatment plants can be planned. The degree of treatment required to meet future population requirements can also be determined by suitable study.

The rapidity with which a stream can recover after the introduction of a pollution load is dependent upon the following variables which influence the activity of aerobic micro-organisms.

(a) The dissolved oxygen present upstream from pollution.

(b) The flow available for dilution.

(c) The intensity, type and volume of the polluting load.

(d) The rate of re-aeration downstream from discharge.

(e) The temperature.

Concentrated stream surveys would therefore require that the dissolved oxygen assets in the stream above the problem areas be studied throughout all seasons of the year, time of day and under varying flow conditions. Low stream flows occurring at each discharge point would be investigated. The nature, strength and quality of waste water discharges

would be determined. The most intense and difficult task is determining the amount of re-aeration occurring. Intense field studies of stream profiles, flow velocities, location and degree of solids deposition, and dissolved oxygen values would be required along the stream reach under investigation.

Prediction of the waste assimilation ability of the stream could then be made from the theoretical methods available.

On the Grand River three critical reaches are indicated by past stream sampling i.e. Kitchener - Waterloo area, Guelph area, Brantford area.

(a) Kitchener - Waterloo Area

This river reach begins in the neighbourhood of the Bridgeport bridge (mileage 110.3) and continues downstream approximately thirty miles to Glen Morris (mileage 82.2). Wastes from Kitchener, Waterloo, Galt, Preston, Hespeler and Bridgeport discharge to the stream within a space of twenty miles from a contributing population of 140,000 persons. At present, the river should be able to sustain the organic loading. However, the population is expanding at greater than 3 per cent per year.

(b) Guelph Reach

The degradation of the Speed River below Guelph and Hespeler experienced in the past indicates that considerable work is necessary to evaluate the self purification powers of this stream from mile 114.7 above Guelph to the confluence with the Grand River. This work should be done in conjunction with the Kitchener area survey considering the proximity of Guelph, Kitchener and Hespeler.

(c) Brantford Area

The second greatest population concentration and organic loading occurs at Paris and Brantford. Waste assimilation studies are required in the reach from Paris (mileage 75.6) to Caledonia (mileage 31.8).

2. Monitoring of Stream Water Quality

The routine sampling programme should provide a complete picture of stream conditions at a number of key points on the stream.

Monthly samples from the following sampling locations are recommended:

G	110.3	Bridgeport at bridge
G	94.3	Blair at bridge
G	86.5	Riverside bridge
G	82.8	Glen Morris dam
G	54.5	at Cainsville
G	0.4	Port Maitland upstream from influence of the lake
GSP	96.9	Speed River at Beaverdale bridge

Sample analysis should include determinations for dissolved oxygen, phosphorus, nitrogens, iron, ABS, and phenols as well as the B.O.D., solids and coliform counts. Additional analyses could be added to detect a particular problem.

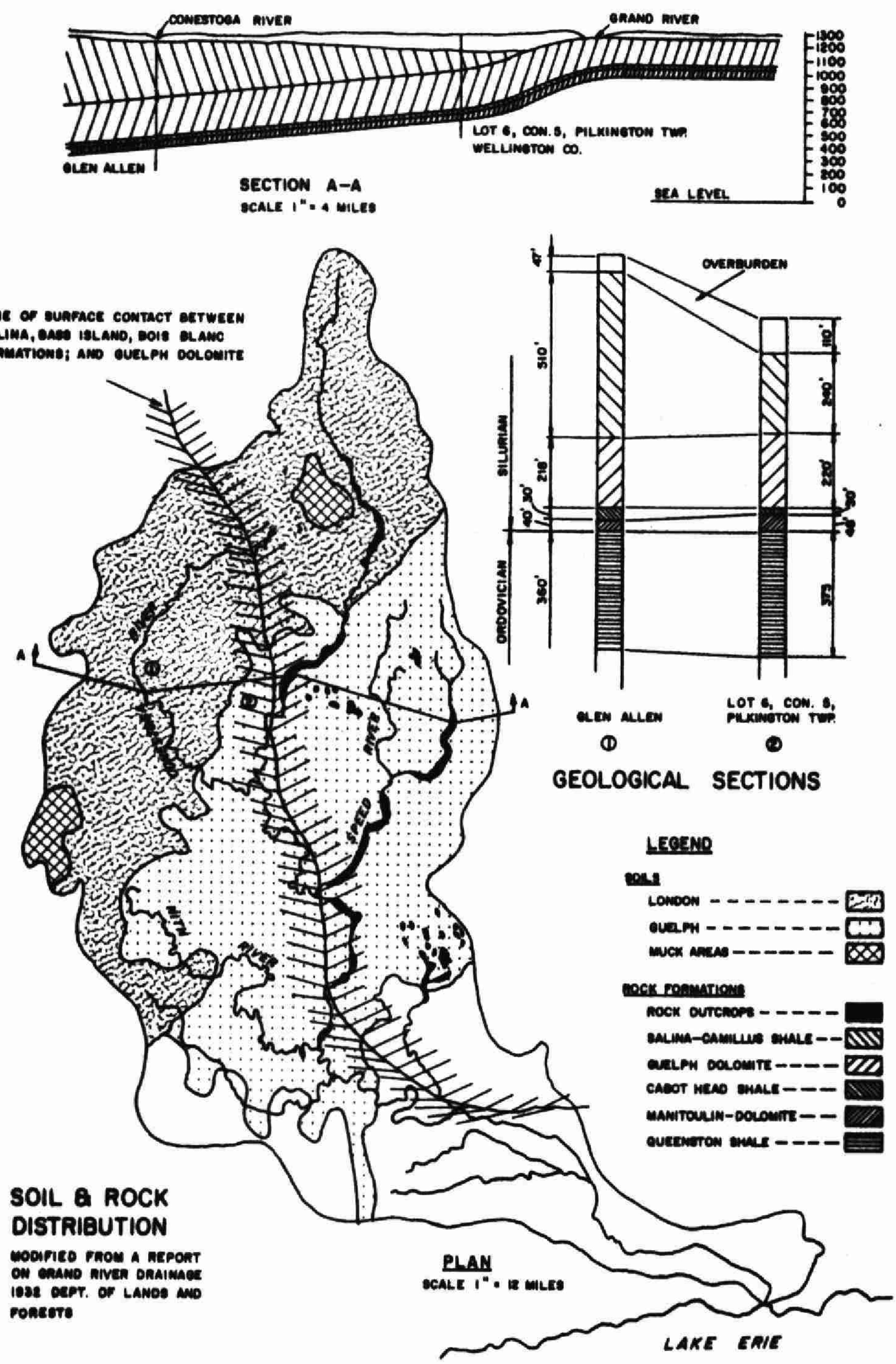
The sampling locations would enable the evaluation of the resultant effects of the major pollution loads. More detailed surveys could be conducted if conditions showed significant change at these locations.

APPENDIX

THE GRAND RIVER AND POLLUTION

TABLES AND FIGURES

FIGURE 2


CONESTOGA RIVER
GRAND RIVER
LOT 6, CON. 5, PILKINGTON TWP.
WELLINGTON CO.
GLEN ALLEN
SECTION A–A
SCALE 1" = 4 MILES
SEA LEVEL
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
LINE OF SURFACE CONTACT BETWEEN SALINA, BASS ISLAND, BOIS BLANC FORMATIONS; AND GUELPH DOLOMITE
OVERBURDEN
SILURIAN
ORDOVICIAN
47'
510'
216'
30'
40'
360'
110'
240'
220'
30'
48'
375'
GLEN ALLEN
LOT 6, CON. 5, PILKINGTON TWP.
GEOLOGICAL SECTIONS
SPEED RIVER
GRAND RIVER
LEGEND
SOILS
LONDON
GUELPH
MUCK AREAS
ROCK FORMATIONS
ROCK OUTCROPS
SALINA–CAMILLUS SHALE
GUELPH DOLOMITE
CABOT HEAD SHALE
MANITOULIN–DOLOMITE
QUEENSTON SHALE
SOIL & ROCK DISTRIBUTION
MODIFIED FROM A REPORT ON GRAND RIVER DRAINAGE 1932 DEPT. OF LANDS AND FORESTS
PLAN
SCALE 1" = 12 MILES
LAKE ERIE

GRAND RIVER AND MAJOR TRIBUTARIES

PHYSICAL DESCRIPTION

Table - 1

Stream	Source	Mouth	Stream Length	Stream Gradient	Drainage Basin Area	Drainage Basin Length	Width	Municipalities
Conestoga River	2 branches 10 mi. north Arthur 10 mi. north-west Arthur	Grand River near Conestoga	50 mi.	10.8'/mi.	317.5 $mi.^2$	38 mi.	4-13 mi.	Arthur, Drayton
Nith River	5 miles south-east of Listowel	Grand River at Paris	98 mi.	6.6'/mi.	432.1 $mi.^2$	45 mi.	Average 10 mi.	Ayr, New Hamburg, Paris, Plattsville
Speed River	18 miles north of Guelph	Grand River 3½ miles above Galt at Preston	37 mi.	15.4'/mi.	187.3 $mi.^2$	37 mi.	4-11 mi.	Guelph, Hespeler, Preston
Eramosa River	25 miles north-east of Guelph	Speed River at Guelph	25 mi.	16.4'/mi.	115.3 $mi.^2$	23 mi.	Average 5 mi.	Guelph
Grand River minus tributaries	5 miles north-east Dundalk	Lake Erie Port Maitland	180 mi.	6.3'/mi.		118 mi.	--	Brantford, Bridgeport, Caledonia, Cayuga, Dundalk, Dunnville, Elora, Fergus, Galt, Grand Valley, Kitchener, Paris, Waterloo

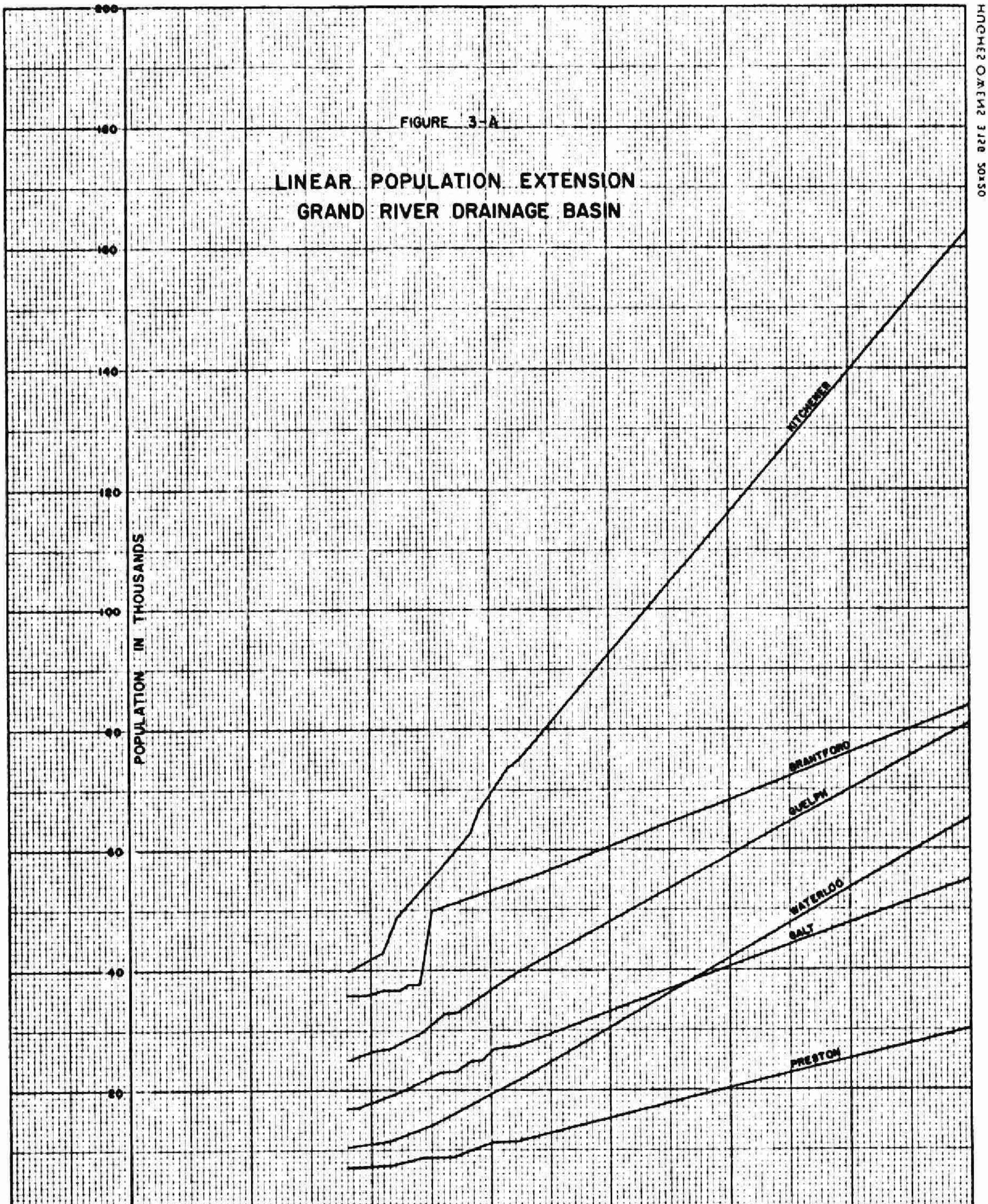


FIGURE 3-A
LINEAR POPULATION EXTENSION
GRAND RIVER DRAINAGE BASIN
POPULATION IN THOUSANDS
KITCHENER
BRANTFORD
GUELPH
WATERLOO
GALT
PRESTON
20
40
60
80
100
120
140
160
180
1940
1950
1960
1970
1980
1990
2000

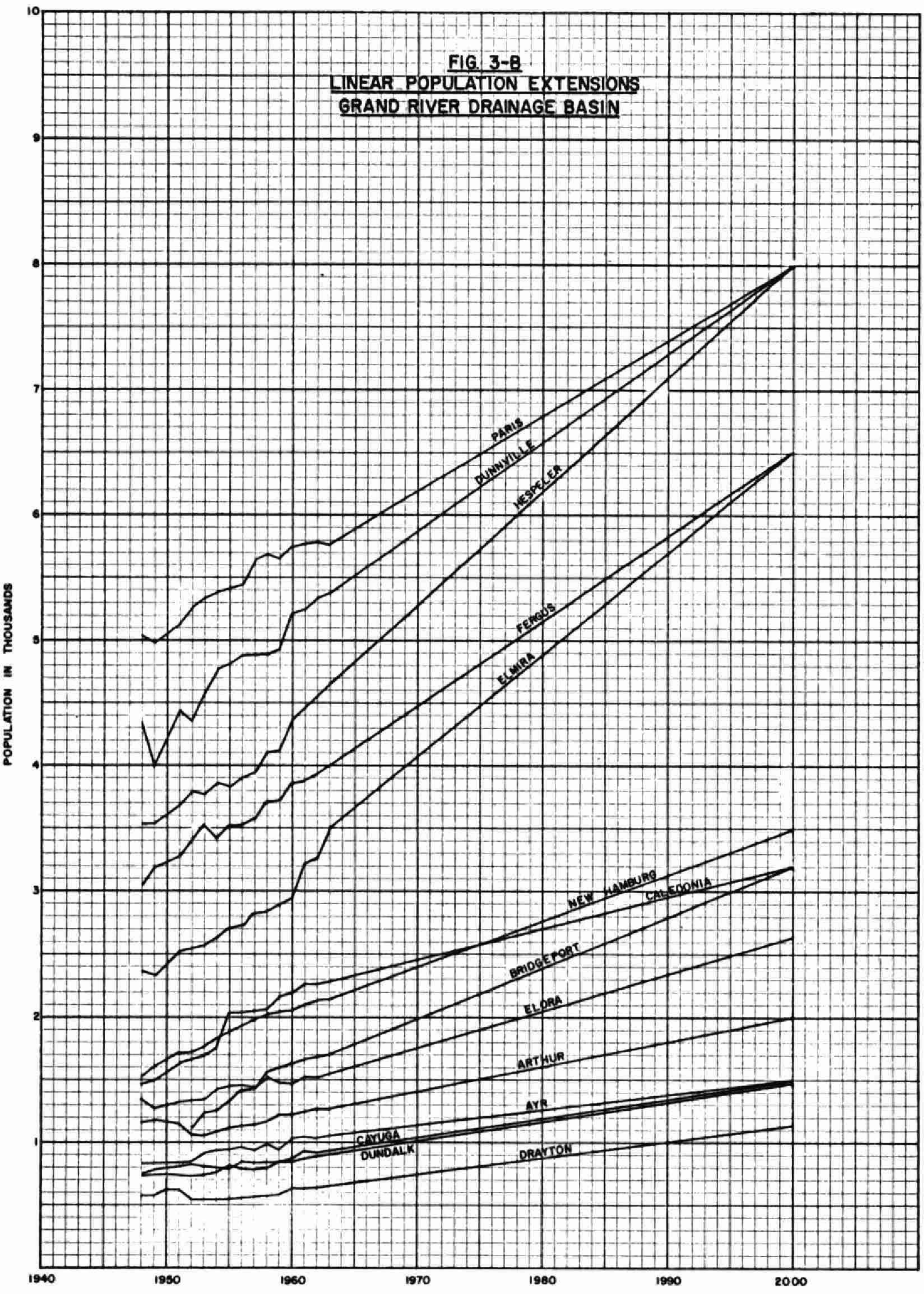


FIG. 3-B
LINEAR POPULATION EXTENSIONS
GRAND RIVER DRAINAGE BASIN
POPULATION IN THOUSANDS
10
9
8
7
6
5
4
3
2
1
1940
1950
1960
1970
1980
1990
2000
PARIS
DUNNVILLE
HESPELER
FERGUS
ELMIRA
NEW HAMBURG
CALEDONIA
BRIDGEPORT
ELORA
ARTHUR
AYR
CAYUGA
DUNDALK
DRAYTON

Table 2

Grand River - Municipalities - Population

Municipalities	County	1963 Population	2000 Population
Cities			
Brantford	Brant	54,372	83,000
Galt	Waterloo	27,679	54,000
Guelph	Wellington	39,790	81,000
Kitchener	Waterloo	77,190	164,000
Waterloo	Waterloo	22,244	64,000
Towns			
Caledonia	Haldimand	2,286	3,200
Dunnville	Haldimand	5,414	8,000
Elmira	Waterloo	3,507	6,500
Fergus	Wellington	3,942	6,500
Hespeler	Waterloo	4,670	8,000
Paris	Brant	5,770	8,000
Preston	Waterloo	11,633	30,000
Villages			
Arthur	Wellington	1,278	2,000
Ayr	Waterloo	1,051	1,500
Bridgeport	Waterloo	1,702	3,200
Cayuga	Haldimand	971	1,500
Drayton	Waterloo	627	--
Dundalk	Grey	929	1,400
Elora	Wellington	1,490	2,200
Grand Valley	Dufferin	697	900
*Milverton	Perth	1,047	--
New Hamburg	Waterloo	2,133	3,500
Wellesley	Waterloo	673	--
Total Urban Population		269,104	532,200

*Not entirely within basin - The watershed passes through a portion of the village.

Table 3

Flows - Grand River at Galt

Water Year	Mean	Maximum	Minimum	Comment
62-63				
61-62				
60-61	765	3,240	368	
59-60				
58-59	1,150	17,300	252	
57-58	847	14,000	222	
56-57	1,170	12,000	389	- Conestoga dam Constructed
55-56	1,750	23,100	228	
54-55	1,490	40,300	255	
53-54	1,220	17,800	257	
52-53	1,150	12,600	130	- Luther dam Constructed
51-52	1,420	13,500	198	
50-51	1,820	18,500	295	
59-50	1,460	26,800	158	
48-49	962	23,200	88	- minimum since dams constructed
47-48	1,210	37,700	137	
46-47	1,940	36,800	112	
45-46	1,190	18,670	151	
44-45	1,230	16,780	169	
43-44	1,020	13,390	121	
42-43	2,010	25,620	193	- Shand dam Constructed
41-42	1,280	20,280	95	
40-41	1,180	20,400	73	
39-40	915	21,200	80	
38-39	1,020	23,110	77	
37-38	1,010	19,750	100	
36-37	1,310	12,050	69	
35-36	740	13,150	26	
34-35	685	18,630	37	
33-34	950	15,160	29	
32-33	1,250	15,470	38	
31-32	1,430	--	-	
30-31	1,170		-	
29-30	483	6,630	-	
28-29	1,790	29,720	-	
27-28	1,230	26,750	-	
26 -27	1,460	20,610	-	

Table 3 (cont.)

Water Year	Mean	Maximum	Minimum	Comment
25-26	1,410	14,520	95	
24-25	750	16,660	49	
23-24	1,180	16,120	110	
22-23	1,000	17,400	93	
21-22	1,270	23,850	75	
20-21	1,180	17,030	90	
19-20	875	20,150	81	
18-19	1,219	30,090	56	
17-18	1,047	21,710	69	
16-17	1,138	25,390	144	
15-16	1,429	19,700	92	
14-15	958	8,926	134	
13-14	626	11,700	55	

TABLE 4

GAUGING STATION DESCRIPTION

STATION	LOCATION	DRAINAGE AREA	GAUGE	PERIOD OF RECORD TO-1958	DISCHARGE AVG.	DISCHARGE MAX.	DISCHARGE MIN.	REMARKS
GRAND R. AT BRANTFORD $2GB_1$	AT THE TORONTO, HAMILTON & BUFFALO R.R. BRIDGE	2010 MI^2	RECORDING, STAFF PRIOR TO 1949	JULY 1913-SEPT 1922 JUNE 1947- TO DATE	1900 C.F.S. (25 YR)	47600 C.F.S. 20 MAR. 1947	24 C.F.S	DISCHARGE AFFECTED BY REGULATION OF SHAND DAM SINCE 1942
GRAND R. AT GALT $2GA_3$	AT THE CONCESSION ST. BRIDGE IN GALT	1360 MI^2	RECORDING, STAFF PRIOR TO 1924	JULY 1913-TO DATE	1210 C.F.S. (50 YR)	40300 C.F.S. OCT. 16 1954	26 C.F.S AUG. 9, 1936	"
GRAND R. BELOW SHAND DAM $2GA_{16}$	A SHORT DISTANCE BELOW THE SHAND DAM NEAR FERGUS	309 MI^2	RECORDING, STAFF PRIOR TO 1951	JULY 1959-TO DATE	329 C.F.S. (13 YR)	9720 C.F.S.	0 C.F.S.	"
GRAND R. AT WALDEMAR 2 GA_{22}	AT BRIDGE IN THE VILLAGE OF WALDEMAR	253 MI^2	RECORDING,	DEC. 1952-TO DATE	260 C.F.S	8310 C.F.S.	1 C.F.S.	DISCHARGE AFFECTED BY REGULATION OF LUTHER DAM
HORNER CREEK NEAR PRINCETON $2GB_6$	AT BRIDGE 1 1/2 MI. N.W. PRINCETON ON THE TWP. ROADS 1 MILE NORTH OF HWY. 2	58 MI^2	WIRE WT. ONCE DAILY	NOV. 1953-TO DATE	62 C.F.S. (10 YR)	1420 C.F.S FEB. 17, 1954	0 C.F.S. AT VARIOUS TIMES	
NITH R. NEAR CANNING $2GA_{10}$	3/4 MI S.E. CANNING, AT THE BRIDGE ON THE E.W. SECONDARY		RECORDING SINCE 1949	JULY 1913-SEPT 1922 1949 TO DATE	379 C.F.S. (15 YR)	11600 C.F.S. OCT. 16, 1954	16 C.F.S.	
NITH R. AT NEW HAMBURG $2GA_{18}$	AT BRIDGE ON MAIN ROAD THROUGH NEW HAMBURG	209 MI^2	TAPE-WEIGHT ONCE DAILY	MAY 1950-TO DATE	213 C.F.S. (23 YR)	5740 C.F.S. OCT. 16, 1954	0 C.F.S. AUG. 14, 1952	
SPEED R. BELOW GUELPH $2GA_{15}$	AT BRIDGE ON SPUR R.R. LINE SERVING CANADA GYPSUM CO.	229 MI^2	STAFF-READ ONCE DAILY	APR. 1949-TO DATE	212 C.F.S. (14 YR)	6720 C.F.S. APR. 4/50	17 C.F.S. OCT. 4/50	
SPEED R. ABOVE GUELPH $2GA_{20}$	AT BRIDGE ON SPEEDVALE AVE. ON N.W. LIMITS OF GUELPH, 500' EAST OF HWY. 6	104 MI^2	STAFF-READ ONCE DAILY	OCT. 1953-TO DATE	90 C.F.S. (10 YR)	2930 C.F.S. AUG. 30/56	2 C.F.S. VARIOUS TIMES	AFFECTED BY REGULATION OF A DAM UPSTREAM
LUTTRELL'S CR. NEAR OUSTIC $2GA_{21}$	AT BRIDGE ON COUNTY RD. RUNNING N.W. FROM ROCKWOOD 1 MILE S.E. OF OUSTIC 7 MILES FROM ROCKWOOD	21 MI^2	WIRE WT READ ONCE DAILY	NOV. 1953-TO DATE	23 C.F.S. (10 YR)	1050 C.F.S. AUG. 30/56	1 C.F.S. VARIOUS TIMES	
CONESTOGA R. AT GLEN ALLAN $2GA_{28}$	AT COUNTY RD. BRIDGE NEAR THE EASTERN LIMITS OF THE HAMLET OF GLEN ALLAN	223 MI^2	RECORDING	OCT. 1959-TO DATE	374 C.F.S. (5 YR)	7600 C.F.S. APR. 5/60	39.6 OCT. 23/59	DISCHARGE EFFECTED BY REGULATION OF CONESTOGA DAM
CONESTOGA R. AT DRAYTON $2GA_{17}$	AT BRIDGE IN DRAYTON ON ROAD LEADING N.W. TO PALMERSTON	125 MI^2	TAPE WT.-READ ONCE DAILY	MAY 1950-TO DATE	128 C.F.S. (13 YR)	5540 C.F.S. APR 4/56	0 C.F.S. AT VARIOUS TIMES	
CANAGAGIGUE CR. NEAR ELMIRA $2GA_{23}$	AT BRIDGE ON TWP. ROAD	42 MI^2	RECORDING	OCT. 1956-TO DATE		298 C.F.S. DEC. 21/57	15 C.F.S. AUG. 9-11/52	DISCHARGE EFFECTED BY REGULATION

Table 5

Sewage Treatment - Urban Municipalities

Municipality	Present Plant	Under Construction	Ownership Date Constructed	Remarks
Arthur	lagoon	--	OWRC 1962-63	serves 40% of town, designed to serve 80% of town in 15 years.
Brantford	activated sludge design flow 12.5 MGD chlorination	None	OWRC 1958	good treatment
Brantford Twp (Burtch Ind. Farm)	activated sludge design flow .043 mgd chlorination		Dept. of Public Works	fair treatment approaching design capacity
Bridgeport	None			should connect to Kitchener sewerage system
Caledonia	activated sludge design flow 0.15 MGD chlorination	None	Municipality	fair treatment
Cayuga	None	None		sewage treatment is required
Dundalk	None	None	---	lagoon proposed, no project to date
Dunnville	None	None		raw sewage pumped to Sunfish Creek, treatment required
Elmira	septic tanks	None		OWRC project, activated sludge plant, in design stage
Elora	None	None	---	OWRC project, modified activated sludge plant in design stage

Table 5 (Cont.)

Municipality	Present Plant	Under Construction	Ownership Date Construction	Remarks
Fergus	activated sludge design flow 0.6 MGD chlorination	None	OWRC 1958-60	sufficient capacity for 4,700 population
Galt	activated sludge design flow 5.0 MGD chlorination	None	OWRC 1962-63	good treatment
Guelph	activated sludge design flow 6.0 MGD	None	Municipality	good treatment chlorination required
Guelph Twp. (Guelph Ind. Farm)	trickling filter chlorination		Dept. of Public Works	
Hespeler	septic tanks - sand filter beds	None	Municipality	poor treatment, improved treatment required, consultant engineer's report being prepared
Kitchener	activated sludge design flow 13.5 MGD		OWRC 1959-62-63	efficient treatment expected
New Hamburg	lagoon	None	OWRC 1961-62	90% of village sewered adequate treatment
Paris	modified activated sludge design flow 0.5 MGD	None	OWRC 1962	sewers under construction
Preston	activated sludge design flow 1.8 MGD	None	OWRC 1962-63	good treatment, capacity for considerable population growth is provided
Waterloo	activated sludge design flow 2.0 MGD chlorination	None	OWRC 1959	improvements to provide more efficient treat- under study

Table 6

Industries Discharging Wastes to the Grand River System

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Brantford	Atlas Powder	chemical wastes	lagoon to creek	connection to municipal sewerage system is planned
	Canada Glue Co. Ltd.	alkaline wastes high in BOD & solids	open ditches to the Grand River	treatment required primary treatment is presently being considered

Other industrial wastes have been suspected of entering storm sewers in the city; however, work is proceeding to connect all industrial wastes, with the exception of Canada Glue and Atlas Powder, to the municipal sewerage system.

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Dunnville	Puritan Dairy Prod. Limited	milk process wastes	wastes discharged to combined sewers and thence to Sunfish Cr.	waste loadings from all of the industrial operations should be included in any sewage treatment plant design
	Dominion Fabrics Limited	textile ind. wastes	"	"
	Grand Valley Canners Ltd.	cannery wastes	"	"
	Monarch Knitting Limited	textile ind. wastes	"	"

Other small industries with insignificant waste quantities also exist in the town, discharging wastes in a similar manner. Provision of municipal treatment facilities would solve their problems also.

Table 6 (Cont.)

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Elmira	Naugatuck Chemicals Ltd.	chemical wastes high in phenols	direct to Canagagigue Creek	wastes from all industrial operations in Elmira will be discharged to the municipal STP
	Reid Bros.	acid fluoride wastes	"	
	Silverwoods Dairy	milk process wastes	"	Naugatuck chemicals are undertaking OWRC project in conjunction with the municipality
Galt	Rauscher Plating	plating wastes	discharged to the Grand R.	treatment on individual basis may be the most economical solution
	Galt Brass Co. Ltd.	"	"	"
	Electronic Coating	"	"	"
	Dominion Tack and Nail	"	"	"
Guelph	Sterling Rubber Co. Ltd.	chemical acid rubber wastes	to Eramosa R. via a storm sewer	should be connected to the Guelph sewerage system under controlled conditions as dictated by a comprehensive industrial waste by-law
	Guelph Stove	plating wastes including cyanide	to Eramosa R.	"

Table 6 (Cont.)

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Guelph Cont'd.	Gilson Mfg. Ltd.	plating wastes including cyanide	to Eramosa R. via a storm sewer	should be connected to the Guelph sewerage system under controlled conditions as dictated by a comprehensive industrial waste by-law.
	National Standard Ltd.	plating waste cooling water	discharge to Speed River	"
	Victoria Dairy	milk wastes	to Speed R. via a storm sewer	"
	Fiberglass Ltd.		to Eramosa R.	"
	Wonderful Soap Co. Ltd.	caustic clean-up - fat process wastes	to Eramosa R.	"
	Harding Carpet Ltd.	wool scouring wastes, dyes	to Speed R.	"
	Newlands Harding Carpets Ltd.	textile wastes	to Speed R.	"
	Biltmore Hats	chemicals, dyes acid	to Eramosa R.	should be connected to the Guelph sewerage system.
	Burrows Textile	dyes and detergents	to Eramosa R.	"
Guelph Twp.	Hart Products	chemical	lagoon discharging to Eramosa R.	should be connected to the Guelph sewerage system.
	Standard Brands	caustic clean-up water	Speed River	"

Table 6 (Cont.)

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Guelph Twp. Cont'd.	Canadian Gypsum Ltd.		Speed River	should be connected to the Guelph sewerage system.
	Mathew Wells	brine solution	Eramosa R.	"
Hespeler	Artex Woolens Limited	textile ind. wastes	discharged directly to Speed River	wastes from all the industries in Hespeler should be discharged to the municipal sewerage system when adequate treatment facilities are provided. Discharge should be controlled by an industrial waste by-law.
	Stamped Enamelled Limited	plating and pickling wastes		
	Dominion Woolens and Worsteds	textile ind. wastes	directly to Speed River	
N. Dumfries	Best Foods	food processing vegetable oils	to the Nith R.	treatment required.
Preston	Kayson Plastics Ltd.	chemical process wastes	polymerized in an open ditch and discharged to the Grand R.	connection to the municipal sewer system should be made.

Other industries in the town are suspected of discharging to storm sewers. Investigations are presently proceeding under the direction of the town engineer.

Paris	Penman's Ltd.	textile ind. wastes	discharged to river	will connect to Paris sewer during 1964. Wastes from all the industries in Paris should be discharged to the municipal sewage treatment facilities.

Tablè 6 (Cont.)

Municipality	Industry	Types of Wastes	Treatment or Disposal	Comment
Paris Cont'd.	Paris Crmy Ltd.	milk process wastes	discharge to river	will connect to Paris sewer during 1964.
	Austin Laboratories Ltd.	pharmecutical wastes	"	Wastes from all the industries in Paris should
	Sunshine Dairy	milk wastes	"	be discharged to the municipal sewage treatment facilities.
Seneca Twp.	Silverwoods Dairy	milk process wastes	wastes discharged to Seneca Cr.	wastes should be directed to the Caledonia sewage treatment plant.
	Gypsum Lime and Alabastine	sanitary wastes	septic tank overflowing to Seneca Cr.	"
	Riverview Dairy	milk process	septic tank seepage to Seneca Cr.	wastes should be directed to the Caledonia sewage treatment plant.
Sherbrooke Township	Dominion Fertilizer Co. Ltd.	extremely strong phosphates high ammonia	scrubber	recommended use of liquid waste free, scrubber system, present treatment inadequate.
	Sherbrooke Metallurgical Limited	sulphates, traces of zinc	neutralized with lime	good treatment.
	Electric Reduction Co. Limited	gypsum sludge, phosphoric acid hydrofluoric acid	neutralized, lagooned	fluoride should be removed from the wastes.
Woolwich Township	Gordon Young Limited	rendering wastes	discharged to Canagagigue Creek	discharge of wastes to the Elmira plant would solve waste disposal problems
Wilmot Twp. Baden	Baden Cheese	milk solids	discharged to Baden Creek	treatment is required.
Petersburg	Tend-R-Flesh Ltd.	chicken processing wastes	lagoons overflowing to Alder Cr. trib.	improved treatment is required.

Table 7

Conservation Storage Reservoir Program

Stream	Damsite Location	Capacity Acre - ft.	Purpose	Status
Grand River	Belwood	49,600	F.S.	constructed
	Luther	10,000	F.S.	"
	Montrose	53,485	F.S.	urged
	Freeport	11,881	F.R.	alternative
Conestoga R.	Conestoga	45,060	F.S.	constructed
	Wallenstein	16,583	F.S.	alternative
	St. Jacobs	13,255	F.S.	"
Nith River	Ayr	23,704	F.S.	urged
	Nithberg	18,800	F.S.	alternative
Speed River	Guelph	11,575	F.R.	urged
	Hespeler	9,666	F.S.	future
Eramosa R.	Everton	15,000	F.S.	future
	Arkell	11,900	F.S.	alternative

F. - flood control
S. - stream flow maintenance
R. - recreation

Table 8

LOW FLOW STUDY - GAUGE AT GALT - 1913-1953

Rank	Frequency	Flows C.F.S. 273 Day Period No Storage	100,000 acre ft.	200,000 acre ft.	Flows C.F.S. 245 Day Period No Storage	100,000 acre ft.	200,000 acre ft.
1	2.5	1245	1430	1615	1204	1389	1594
2	5.0	1153	1338	1523	1178	1384	1588
3	7.5	1126	1311	1496	1096	1301	1506
4	10.0	1077	1262	1447	1971	1276	1481
5	12.5	1063	1248	1433	1016	1221	1426
6	15.0	1019	1204	1389	1010	1215	1420
7	17.5	1015	1200	1385	1010	1215	1420
8	20.0	1003	1188	1373	1007	1212	1417
9	22.5	996	1181	1366	941	1146	1351
10	25.0	984	1169	1354	896	1101	1306
11	27.5	966	1151	1336	849	1054	1259
12	30.0	836	1021	1206	831	1036	1241
13	32.5	825	1010	1195	814	1019	1224
14	35.0	812	997	1182	708	913	1118
15	37.5	767	952	1137	680	885	1090
16	40.0	703	888	1037	644	849	1054
17	42.5	660	845	1030	612	817	1022
18	45.0	596	781	966	502	707	912
19	47.5	592	777	962	495	700	905
20	50.0	589	774	959	471	676	881
21	52.5	504	689	874	468	673	878
22	55.0	496	681	866	467	672	877
23	57.5	486	671	836	456	661	866
24	60.0	484	669	854	444	649	854
25	62.5	453	638	823	412	617	822
26	65.0	446	631	816	405	610	815
27	67.5	441	626	811	396	601	806
28	70.0	440	625	810	389	594	799
29	72.5	407	592	777	316	521	726
30	75.0	387	572	757	291	496	701
31	77.5	328	513	698	283	488	693
32	80.0	315	500	685	281	486	691
33	82.5	285	470	655	277	482	687
34	85.0	283	468	653	266	471	676
35	87.5	261	446	631	234	439	644
36	90.0	254	439	624	214	419	624
37	92.5	219	404	589	190	395	600
38	95.0	182	367	552	188	393	598
39	97.5	160	345	531	166	371	576

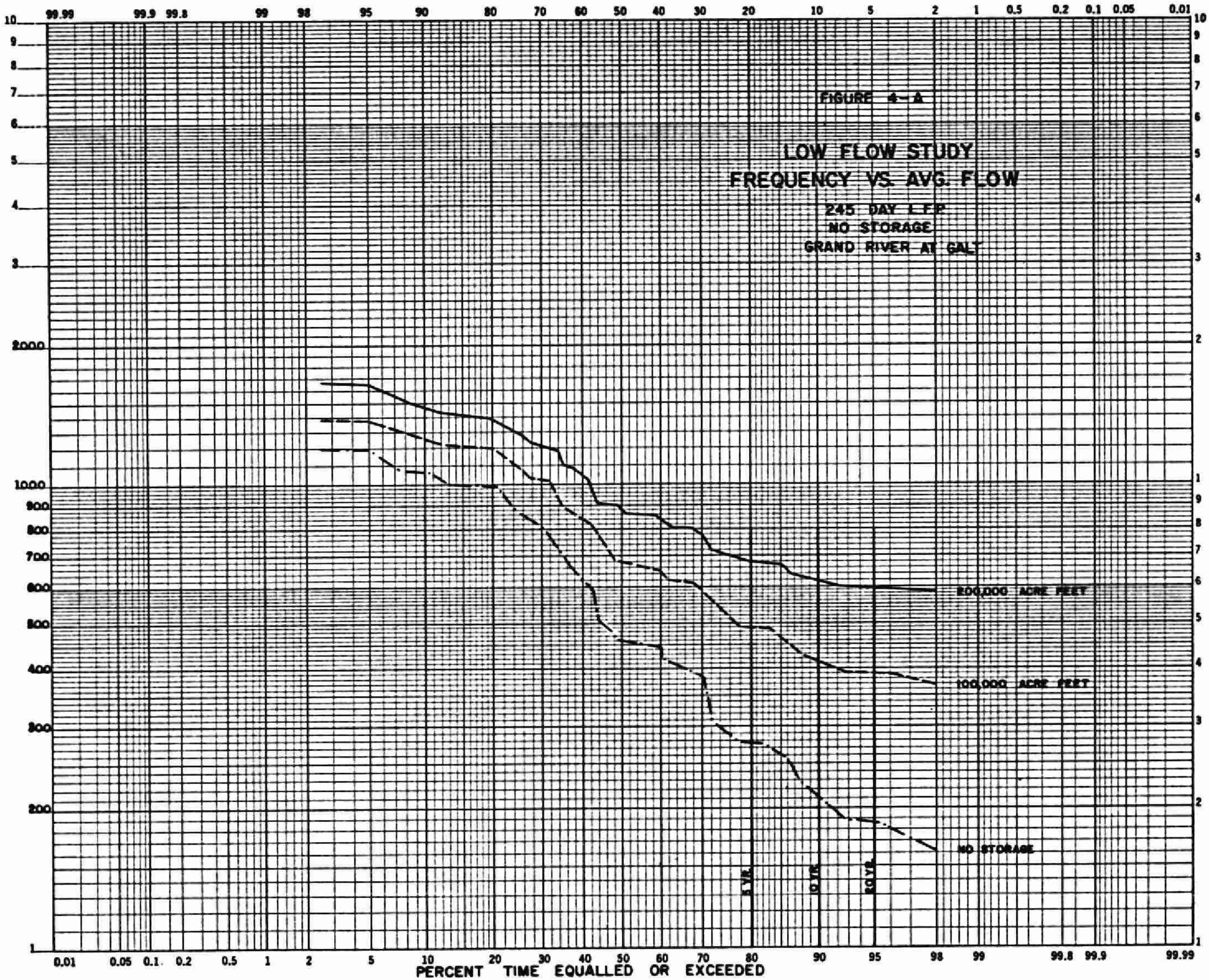


FIGURE 4-A
LOW FLOW STUDY
FREQUENCY VS. AVG. FLOW
245 DAY L.F.P.
NO STORAGE
GRAND RIVER AT GALT
200,000 ACRE FEET
100,000 ACRE FEET
NO STORAGE
5 YR.
10 YR.
20 YR.
FLOW IN C.F.S.
PERCENT TIME EQUALLED OR EXCEEDED

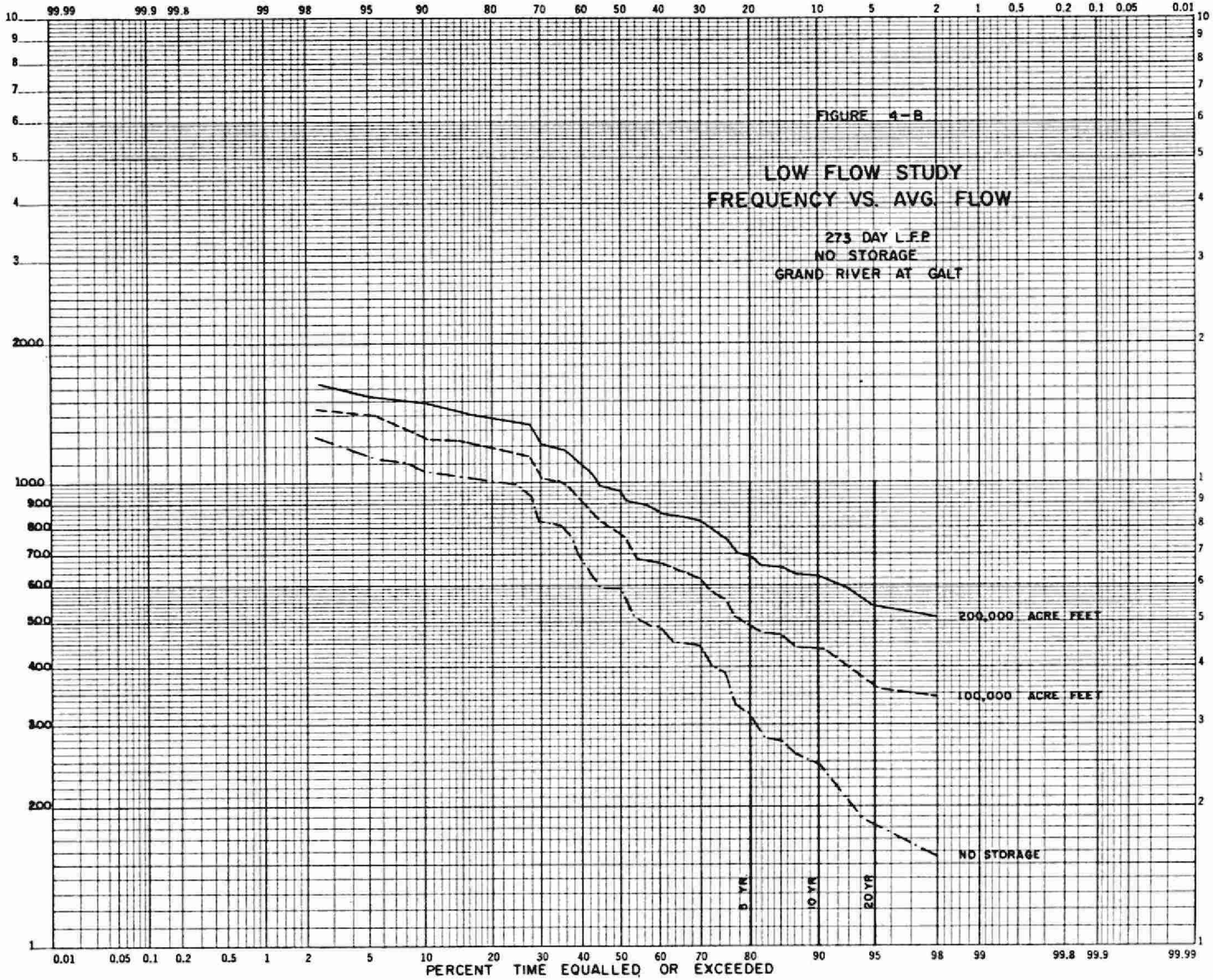


FIGURE 4-B
LOW FLOW STUDY
FREQUENCY VS. AVG. FLOW
273 DAY L.F.P.
NO STORAGE
GRAND RIVER AT GALT
200,000 ACRE FEET
100,000 ACRE FEET
NO STORAGE
5 YR.
10 YR.
20 YR.
FLOW IN CFS.
PERCENT TIME EQUALLED OR EXCEEDED

Table 9

FREQUENCY OF OCCURRENCE OF AVERAGE FLOWS

DURING LOW FLOW PERIODS

245 DAY PERIOD

Frequency	1:20	1:10	1:5
Storage			
No storage	188	215	281
100,000 acre feet	393	420	486
200,000 acre feet	598	625	691

273 DAY PERIOD

No storage	180	250	315
100,000 acre feet	365	435	500
200,000 acre feet	550	620	685

Flows Reported in cubic feet per second.

TABLE 10

B.O.D.

GRAND RIVER SAMPLING SURVEYS

MAIN GRAND RIVER

		MAY 8/57	JULY 14/59	JULY 19/60	APR.19/61	OCT.10/62	FEB.15/63
G 0.4	AT SOUTH TURN OF RYMER RD., PORT MAITLAND	-	4.4	1.7	6.8	6.6	2.0
G 4.3	100 FT. BELOW CONFLUENCE WITH SUNFISH CREEK						5.8
G 4.3	100 FT. ABOVE CONFLUENCE WITH SUNFISH CREEK						1.7
G 4.9	AT DUNNVILLE EAST DAM	—	3.4	1.8	5.6	5.2	1.9
G10.8	AT END OF ROAD TO CANFIELD JUNCTION		4.4	2.6	8.0		
G20.3	AT CAYUGA HWY.#3 BRIDGE	4.2	2.1	2.6	7.2	4.4	
G26.3	AT YORK BRIDGE		4.4	2.6	7.2		
G30.1	BELOW CALEDONIA AT 1ST SIDE ROAD EAST		3.9	3.8	6.2		
G30.5	100' DOWNSTREAM FROM SENECA CR.					5.2	2.2
G30.6	100' UPSTREAM FROM SENECA CR.					4.8	
G31.8	AT CALEDONIA AT DAM	2.8	7.0	2.3		4.8	
G39.5	AT CHIEFSWOOD FERRY		4.4	10.0	5.0	4.2	
G49.9	BELOW BRANTFORD WHERE RIVER ROAD TURNS SHARP WEST	2.5	3.8	8.0	6.8		
G54.5	AT CAINSVILLE 1ST SIDE ROAD EAST OF ECHO PLACE		14	8.4	8.4	12	
G59.1	AT MAIN ROAD TO BURTCH		6.0	2.0	4.2		4.1
G62.8	AT JUNCTION HWY.#2 & 24		3.2	4.0	10.0	2.7	3.9
G73.2	BELOW PARIS AT ROAD BETWEEN CONCESSIONS 1 & 2	2.1	1.5	5.8	4.4		
G75.6	AT PARIS DAM	2.4	1.4	4.6	3.8	1.4	5.3
G82.8	AT DAM AT GLEN MORRIS	3.3	2.0	3.2	4.4	2.6	6.0
G86.5	AT RIVERSIDE BRIDGE BELOW GALT	2.5	3.0	7.4	5.2		8.8
G89.8	AT GALT DAM	7.1	2.2	6.4	1.5	5.8	5.6
G94.3	AT BLAIR AT BRIDGE	5.8	3.6	5.2	4.2	7.3	9.6
G101.0	AT FREEPORT BRIDGE	2.3	2.3	3.8	3.8	3.2	5.0
G106.8	AT BRESLAU BRIDGE	4.5	5.4	3.4	4.4	5.8	3.7
G110.3	AT BRIDGEPORT BRIDGE	2.6	2.2	3.5	2.8	6.6	3.7
G118.4	AT CONESTOGA AT BRIDGE ABOVE JUNCTION	2.3	1.6	3.2	3.3	3.0	

MAIN GRAND RIVER CONT'D.

		MAY 8/57	JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
G 129.3	AT BRIDGE CONC. 4 BELOW ELORA	1.4	1.3	1.6	2.5		
G 134.1	AT BRIDGE AT ELORA	1.4	1.5	1.6	2.3	2.7	3.9
G 137.3	AT FOOTBRIDGE BELOW FERGUS		1.8	3.0	2.8	1.8	4.2
G 139.9	AT BRIDGE NE END OF FERGUS	1.3	1.3	5.2	3.0	1.8	
G 140.3	AT BRIDGE CONC. 2 BELOW SHAND DAM	1.0	1.7	2.6	2.5		
G 145.6	AT BELWOOD BRIDGE	1.2	2.1	2.2	--	--	--
G 153.4	BELOW WALDEMAR HWY. #9	1.5	3.7	2.2	--	--	--
G 154.6	BRIDGE CONC. 9 BELOW GRAND VALLEY	0.7	3.3	2.1	--	2.1	
G 159.6	BRIDGE CONC. 4 LUTHER TWP.	1.2	2.2	3.8	--	--	--
G 176.4	BELOW RIVERVIEW AT BRIDGE		0.6	2.8	--	--	--
G 182.0	1ST SIDE RD. WEST OF DUNDALK		1.3	2.2	--	3.6	--

CONESTOGA RIVER

		MAY 8/57	JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GCO118.9	CONESTOGA R. JUST ABOVE GRAND R.			1.1	3.4	3.0	5
GCO119.9	CONESTOGA R. AT COUNTY RD. BRIDGE ½ MILE BELOW ST. JACOBS		1.9	1.0			
GCO122.4	CONESTOGA R., ST. JACOBS BELOW RAILWAY		1.3	0.6			
GCO129.2	AT BRIDGE AT HAWKESVILLE		1.2				
GCO129.6	AT DAM NORTH END OF HAWKESVILLE		1.0				
GCO138.6	AT BRIDGE JUST BELOW GLEN ALLEN		2.5	1.4	3.0		
GCO148.6	MOOREFIELD BRANCH CONC. RD. 1½ MILES BELOW MOOREFIELD		2.2				
GCO148.9	AT MILL ST. DRAYTON		1.9	0.6		4.8	
GCO149.3	AT WELLINGTON ST. BRIDGE DRAYTON		2.0	0.7			
GCO159.3	AT HWY.#9 1½ MILES WEST OF ARTHUR		1.1	2		2.8	
GCO160.8	250' BELOW STORM SEWER OUTFALL ARTHUR		110	36		30	
GCO162.0	AT HWY.#9 EAST OF ARTHUR		1.8				

NITH RIVER

		JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GN 75.3	AT HWY.#24A AT MOUTH	0.6	1.9	4.8	2.0	3.1
GN 81.4	AT BRIDGE SE OF CANNING	0.9	1.9			
GN 85.3	AT CANNING BRIDGE	0.8	0.9	3.4		
GN 89.3	AT BRIDGE EAST OF RICHMOND	1.2	1.4			
GN 97.1	AT WOLVERTON BRIDGE CONC. 7	1.4	2.2	2.8		
GN 97.8	AT BRIDGE SOUTH OF WOLVERTON	1.3				
GN 98.5	ABOVE WOLVERTON 1ST SIDE ROAD EAST		4.4	5.6		
GN101.6	AT FALKLAND RD. BELOW AYR	2.0	6.4		3.0	
GN104.1	AT CPR BRIDGE AYR	1.7				
GN105.8	AT TWP. LINE BRIDGE WEST OF AYR	2.9	4.0		2.0	
GN116.5	½ MILE BELOW PLATTSVILLE		2.2	2.8	5.6	
GN124.2	AT CONC. RD. AT HAYSVILLE	3.4	3.2		3.6	
GN130.1	AT BY-PASS RD. BRIDGE S. OF NEW HAMBURG	1.9	2.0		3.2	
GN133.2	AT SHADE ST. NEW HAMBURG		1.7		2.6	
GN153.2	COUNTY RD. 2½ MILES ABOVE NITHBURG	1.1	1.9			
GN159.1	AT ELGIN ST. BRIDGE MILLBANK	18	9.2		24	
GN159.6	AT WATERLOO ST. BRIDGE NE END MILLBANK	3.4	5.2			

SPEED AND ERAMOSA RIVERS

		JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GSP 94.2	SPEED R. ABOVE JUNCTION WITH GRAND BELOW PRESTON	4.0		3.6		
GSP 94.7	SPEED R. AT HWY.#8		4.2		6.0	6.7
GSP 96.9	SPEED R. ABOVE PRESTON BELOW HESPELER BEAVERDALE BRIDGE	7.2	10.		6.4	9.2
GSP 98.4	SPEED R. AT DAM ABOVE STAMPED ENAMELLED WARE		4			
GSP100.0	SPEED R. ABOVE HESPELER	3.6				
GSP105.2	SPEED R. AT BRIDGE RD. BETWEEN CONC. 5 & 6 PUSLINCH TWP.	3.8	13		9.6	4.0
GSP108.1	SPEED R. AT BRIDGE BELOW HWY.#6				2.0	
GSP108.4	SPEED R. AT HWY. #6 BRIDGE	2.7	2.4			
GSP108.9	ERAMOSA R. ABOVE JUNCTION WITH SPEED		3.4		2.8	
GSP109.0	SPEED R. AT HWY. #7 BRIDGE	2.7	6.0		2.3	3.7
GSP109.3	ERAMOSA R. AT WATER WORKS GUELPH	1.8	1.2			

Speed & Eramosa River Con't

		July 14/59	July 19/60	Apr. 19/61	Oct. 10/62	Feb. 15/63
GSP109.7	Speed R. at Bridge Eramosa Rd.	2.1	6.2			
GSP109.9	Eramosa R. at Victoria St. Bridge Conc. 8	2.4	3.6		14	18
GSP110.7	Eramosa R. at Guelph Reformatory	2.2	0.3			
GSP111.2	Speed R. at park in Guelph	1.6	1.0		1.9	
GSP114.7	Eramosa R. ½ mile below Eden Mills	0.7	1.0		1.9	2.2
GSP117.7	Eramosa R. at Rd. between Conc. 3 & 4 Eramosa Twp.	13	0.7			
GSP118.7	Eramosa R. at Hwy. #7 at Rockwood	1.8	1.4			3.1

Canagagigue Creek

GCG125.6	At side road 1¼ mile S. E. of Elmira	59.	12		31	40
GCG128.6	At Conc. Road 1¼ mile North of Elmira	1.6	2.8		2.2	
GCG130.1	At Floradale 100' below mill race	4.6				
GCG130.8	¼ mile above Floradale	3.4				
GCG132.8	At Township line just above Conc. VI Peel Township	1.8				

TABLE II

M.F. COLIFORM COUNTS

GRAND RIVER SAMPLING SURVEYS

MAIN GRAND RIVER

		May 8/57	July 14/59	July 19/60	Apr. 19/61	Oct. 10/62	Feb. 15/63
G 0.4	At south turn of Rymer Rd., Port Maitland	--	100	10	30	29,000	550
G 4.3	100 ft. below confluence with Sunfish Creek	--	--	--	--	81,000	--
G 4.3	100 ft. above confluence with Sunfish Creek	--	--	--	--	--	430
G 4.9	At Dunnville east dam	< 200 *	59	40	10	4,500	134
G10.8	At end of road to Canfield Junction	--	--	8	30		7,000
G20.3	At Cayuga Hwy.#3 bridge	< 200 *	9	28	10	158	--
G26.3	At York Bridge	--	100	20	20	66	--
G30.1	Below Caledonia at 1st side road east	--	900	12	10	--	--
G30.5	100' downstream from Seneca Cr.	--	--	--	--	41,000	1,170
G30.6	100' upstream from Seneca Cr.	--	--	--	--	3,700	--
G31.8	At Caledonia at dam	< 200 *	--	10	--	200	--
G39.5	At Chiefswood Ferry	--	1,400	190	540	320	--
G49.9	Below Brantford where river road turns sharp west	4,500 *	50	1,540	40	--	--
G54.5	At Cainsville 1st side road east of Echo Place	--	1,300	17,000	30	690	--
G59.1	At main road to Burtch	--	300	70	10	--	1,400
G62.8	At junction Hwy. #2 & 24	--	4,100	--	T	1,900	1,300
G73.2	Below Paris at road between concessions 1 & 2	< 200 *	220	90	970	--	--
G75.6	At Paris Dam	4,500 *	200,000	440	--	1,400	4,300
G82.2	At dam at Glen Morris	7,800 *	2,900	12,000	0	17	30,000
G86.5	At Riverside bridge below Galt	4,000 *	4,500	1,830	10	--	6,700
G89.8	At Galt dam	540,000 *	650,000	38,000	0	11,000	6,900
G94.3	At Blair at bridge	130,000 *	6,500	101,000	30	5,300	65,000
G101.0	At Freeport bridge	17,000 *	500,000	2,270	0	1,290	32,000
G106.8	At Breslau bridge	240,000 *	6,300,000	1,930	0	40,000	9,000
G110.3	At Bridgeport bridge	< 20 *	56,000	91,000	420	21,000	6,380
G118.4	At Conestoga at bridge above junction	200	4,900	29,000	10	100	--

* DENOTES MPN TEST

MAIN GRAND RIVER CONT'D.

		MAY 8/57	JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
G 129.3	AT BRIDGE CONC. 4 BELOW ELORA	2,400 *	250	15,000	60	--	--
G 134.1	AT BRIDGE AT ELORA	9,500 *	45,000	272,000	230	2,000	--
G 137.3	AT FOOTBRIDGE BELOW FERGUS		146,000	11,000	110	5,200	38,000
G 137.9	AT BRIDGE NE END OF FERGUS	790 *	140	120	0	88	
G 140.3	AT BRIDGE CONC. 2 BELOW SHAND DAM	20 *	50	20	0		
G 145.6	AT BELWOOD BRIDGE	220 *	700	40	--	--	--
G 153.4	BELOW WALDEMAR HWY. #9	130 *	30	27	--	--	--
G 154.6	BRIDGE CONC. 9 BELOW GRAND VALLEY	78 *	30	21			
G 159.6	BRIDGE CONC. 4 LUTHER TWP.	45 *	44	40			
G 176.4	BELOW RIVERVIEW AT BRIDGE		64	200			
G 182.0	1ST SIDE RD. WEST OF DUNDALK		30	190			1,900

CONESTOGA RIVER

		JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GC0118.9	CONESTOGA R. JUST ABOVE GRAND R.		130	0	800	2,070
GC0119.9	CONESTOGA R. AT COUNTY RD. BRIDGE ½ MILE BELOW ST. JACOBS	200	490			
GC0122.4	CONESTOGA R., ST. JACOBS BELOW RAILWAY	40	200			
GC0129.2	AT BRIDGE AT HAWKESVILLE	100				
GC0129.6	AT DAM NORTH END OF HAWKESVILLE	20				
GC0138.6	AT BRIDGE JUST BELOW GLEN ALLEN	30	11	1		
GC0148.6	MOOREFIELD BRANCH CONC. RD. 1½ MILES BELOW MOOREFIELD	210				
GC0148.9	AT MILL ST. DRAYTON	370	270		57,000	
GC0149.3	AT WELLINGTON ST. BRIDGE DRAYTON	74,000	< 10			
GC0159.3	AT HWY.#9 1½ MILES WEST OF ARTHUR	5,000	20		500	
GC0160.8	250' BELOW STORM SEWER OUTFALL ARTHUR	90,000	1,790,000		2,000,000	
GC0162.0	AT HWY. #9 EAST OF ARTHUR	200				

NITH RIVER

		JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GN 75.3	AT HWY.#24A AT MOUTH	60,000	370	220	45,000	510
GN 81.4	AT BRIDGE SE OF CANNING	100	90			
GN 85.3	AT CANNING BRIDGE	100	20	20		
GN 89.3	AT BRIDGE EAST OF RICHWOOD	50	120			
GN 97.1	AT WOLVERTON BRIDGE CONC. 7	40	110	40		
GN 97.8	AT BRIDGE SOUTH OF WOLVERTON	< 100				
GN 98.5	ABOVE WOLVERTON 1ST SIDE ROAD EAST		220	40		
GN101.6	AT FALKLAND RD. BELOW AYR	400	130		1,400	
GN104.1	AT CPR BRIDGE AYR	430				
GN105.8	AT TWP. LINE BRIDGE WEST OF AYR	40	90		28	
GN116.5	½ MILE BELOW PLATTSVILLE		310	50	830	
GN124.2	AT CONC. RD. AT HAYSVILLE	130	820		340	
GN130.1	AT BY-PASS RD. BRIDGE S. OF NEW HAMBURG		5,000		1,200	
GN133.2	AT SHADE ST. NEW HAMBURG		420		14,000	
GN153.2	COUNTY RD. 2½ MILES ABOVE NITHBURG		50			
GN159.1	AT ELGIN ST. BRIDGE MILLBANK	4,000	670		2,600	
GN159.6	AT WATERLOO ST. BRIDGE NE END MILLBANK	40	< 100			

SPEED AND ERAMOSA RIVERS

		JULY 14/59	JULY 19/60	APR. 19/61	OCT. 10/62	FEB. 15/63
GSP 94.2	SPEED R. ABOVE JUNCTION WITH GRAND BELOW PRESTON	250,000		0		
GSP 94.7	SPEED R. AT HWY. #8		129,000		21,000	44,000
GSP 96.9	SPEED R. ABOVE PRESTON BELOW HESPELER BEAVERDALE BRIDGE	12,000	171,000		68,000	172,000
GSP 98.4	SPEED R. AT DAM ABOVE STAMPED ENAMELLED WARE		130			
GSP100.0	SPEED R. ABOVE HESPELER	2,500				
GSP105.2	SPEED R. AT BRIDGE RD. BETWEEN CONC. 5 & 6 PUSLINCH TWP.	12,000	440		130,000	91,000
GSP108.1	SPEED R. AT BRIDGE BELOW HWY.#6				1,700	
GSP108.4	SPEED R. AT HWY. #6 BRIDGE	15,000	56,000			
GSP108.9	EROMOSA R. ABOVE JUNCTION WITH SPEED		840		700	
GSP109.0	SPEED R. AT HWY.#7 BRIDGE	15,000	217,000		5,800	900
GSP109.3	ERAMOSA.R. AT WATER WORKS GUELPH	58,000	22,000			

SPEED & ERAMOSA RIVER CON'T

		JULY 14/59	JULY 19/59	APR. 19.61	OCT. 10/62	FEB. 15/62
GSP109.7	SPEED R. AT BRIDGE ERAMOSA RD.	10,000	44,000			
GSP109.9	ERAMOSA R. AT VICTORIA ST. BRIDGE CONC. 8	25,000	10,000		36,000	8,800
GSP110.7	ERAMOSA R. AT GUELPH REFORMATORY	75,000	40			
GSP111.2	SPEED R. AT PARK IN GUELPH	156,000	150		580	
GSP114.7	ERAMOSA R. ½ MILE BELOW EBEN MILLS	72,000	380		160	70
GSP117.7	ERAMOSA R. AT ROAD BETWEEN CONC. # & 4 ERAMOSA TWP.	57,000	40			
GSP118.7	ERAMOSA R. AT HWY. #7 AT ROCKWOOD	840	270			—

CANAGAGIGUE CREEK

GCG125.6	AT SIDE ROAD 1¼ MILE S.E. OF ELMIRA	310,000	9,700		1,400,000	35,000
GCG128.6	CANAGAGIGUE CREEK 1¼ MILE NORTH OF ELMIRA	4,100,000	1,300		146	
GCG130.1	AT FLORADALE 100' BELOW MILL RACE	920				
GCG130.8	¼ MILE ABOVE FLORADALE	240				
GCG132.8	AT TOWNSHIP LINE JUST ABOVE CONC. VI PEEL TOWNSHIP	70				

Table 12

Grand River Water Pollution Survey

October 9-10 1963

Main Grand River

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
G 0.4	At south turn of Rymer Rd.(west side)	2.4	482	0.62	11.0	25		1,320
	" (east side)	2.5	502	0.52	21.0	39		1,700
G 2.4	Just above Cranbury Creek (west side)	2.7	542	--	14.0	--	--	37,000
	" (east side)	2.8	506	--	11.5	--	--	5,400
GSU4.3	Sunfish Creek at mouth	285	2044	1.2		25		23,000,000
GSU4.5	Sunfish Creek at first bridge	165	3226	--	--	--	--	-
G 4.9	At Dunnville Dam	2.2	536	--	24.0	--	--	1
G 19.6	At islands below Cayuga	1.7	498	--				11.000
G 26.3	At York Bridge	2.8	490	--	10.5	--	--	150

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
G 30.1	Below Caledonia							
	(west side)	3.8	472	--	11.0	--	--	120
	(east side)	4.1	508	--	9.5	--	--	230
G 31.3	At Hwy.#6	4.0	526	--	18.0	--	--	140
G 54.5	At Cainsville	92	680	--	--	--	8.0	23,300,000
G 59.1	Brantford Erie St. bridge	1.5	476	--	2.6	--	--	930
G 62.8	At Hwy. 2 & 24	1.5	472	--	2.3	--	--	2,400
G 74.9	At Hwy. 5 bridge	1.4	464	--	2.6	--	--	10,000
G 75.6	At Paris dam	1.8	396	--	0.7	--	--	1,000
G 82.8	At Glen Morris bridge	1.9	390	--	0.8	--	--	20,000
G 86.5	At Riverside bridge	2.4	382	--	1.7	--	--	6,000
G 89.8	At Bridge at Galt	2.2	366	--	2.3	--	--	580
G 94.3	At Blair at bridge	3.9	316	--	2.1	--	--	21,000

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
G 97.3	Schneider Cr. at river road	4.6	570	--	6.5	--	--	270
G 97.7	At historical site Pioneer Tower	6.4	592	--	--	--	--	3,900
G101.0	At Freeport bridge	2.3	280	--	2.8	--	--	1,060
GBR107.1	Breslau Creek at Breslau bridge	3.3	386	--	7.0	--	--	160
G106.8	At Breslau bridge	2.5	272	--	3.5	--	--	21,000
G110.3	At Bridgeport bridge	1.3	258	--	4.0	--	0.0	600
G118.4	At bridge in Conestoga	2.0	260	--	1.4	--	100	30
G129.3	At bridge concession 4 below Elora	1.4	218	--	1.7	--	--	70
GI134.0	Irvine Cr. at David St. Elora	1.2	250	--	2.3	--	--	1,700
G 134.1	At bridge Elora	1.4	258	--	2.3	--	--	210

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
G 137.3	At old foot bridge site below Fergus	1.7	220	--	3.3	--	--	98
G 158.5	At bridge N.E. end of Fergus	1.7	214	--	2.1	--	--	36
G 153.4	At Hwy. 9 below Waldemar	1.3	218	--	1.4	--	--	236
G 154.6	At Conc. 9 above Waldemar	1.2	202	--	2.6	--	--	32
G 159.6	At Conc. 4 above Grand Valley	1.3	188	--	7.5	--	--	150
	Conestoga River							
GC0118.9	At side road bridge 3/4 miles above junction	1.1	234	--	7.0	--	--	740
GC0119.9	At county road bridge 1½ miles below St. Jacobs	1.5	234	--	8.0	--	--	9,000

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
GC0122.4	At railway bridge - St. Jacobs	1.8	262	--	11.5	--	--	430
GC0148.9	At Mill Street - Drayton	2.8	272	--	9.0	--	--	57,000
GC0149.3	At Wellington Street bridge	1.2	274	--	11.0	--	--	290
GC0159.3	At Hwy. 9 bridge, 1¼ miles west of Arthur	1.5	378	--	29.0	--	--	490
GC0160.8	At Charles St. Bridge, west end of Arthur	4.0	656	--	16.0	--	--	2,800
GC0162.0	At Hwy.9 bridge just east of Arthur	1.5	320	--	11.0	--	--	70
				Nith River				
GN 75.3	Nith R. at Hwy. 24A - Paris (at mouth of river)	1.4	508	--	2.8	--	--	7,000

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
GN 101.6	Nith R. at bridge below Ayr	1.9	420	--	2.6	--	--	2,100
GNC 103.7	Cedar Cr. at Ayr just above mouth	1.1	364	--	1.0	--	--	1,900
GNC 103.9	Cedar Cr. at bridge N.E. end of Ayr	1.2	398	--	1.1	--	--	154
GNA 109.6	Alder Cr. at #97 Hwy.	1.1	528	--	1.8	--	--	1,900
GNA 111.8	Alder Cr. at 1st bridge below New Dundee	1.5	462	--	2.1	--	--	2,200
GNA 120.2	Alder Cr. at New Dundee Petersburg Rd. *	41.	590	--	--	--	--	8,300
GNA 127.4	Alder Cr. at Mannheim *	5.2	492	--	--	--	--	3,600
GN 116.5	Nith R. at bridge ½ mile below Plattsville	2.3	438	--	3.5	--	--	880

Table 12 (Cont.)

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
GN 124.2	Nith R. at Haysville bridge	1.7	342	--	5.5	--	--	56
GNB 128.8	Baden Cr. at #8 Hwy.	4.5	378	--	--	--	--	21,000
GN 127.3	Nith R. at Steel bridge on dead end rd. downstream from N.H. lagoon	3.1	320	--	--	--	--	1,000
GN 130.1	Nith R. at #8 By-pass New Hamburg	2.5	304	--	--	--	--	460
GNW 147.2	Campbells Cr. at Conc. Rd. S. of Wellesley	4.2	268	--	--	--	--	6,100
GN 159.1	Nith R. at Elgin 17. St. Bridge - Millbank (no flow)		526	--	--	--	--	81,000

* Contains effluent from New Dundee Creamery & Tend-R-Flesh Limited

Table 12 (Cont.)

Speed & Eramosa Rivers

Sample Pt.	Description	5-Day BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
GSP 94.7	Just above Hwy. 8 bridge, Preston	3.1	554	--	4.0	--	--	2,800
GSP 96.9	At Beaverdale Bridge ¼ mile S.W. of Hespeler	10.	582	--	8.0	--	--	137,000
GSP 98.4	At dam above Stamped Enamelled Ware	3.7	500	--	10.5	--	--	330
GSP105.2	At bridge, Conc. Road 5 & 6 Puslinch Twp. (below Guelph)	3.6	478	--	3.6	--	--	1,700
GSP106.7	150 ft. below Guelph STP Outfall	21.	810	--	18.0	--	--	18,000,000
GSP108.1	At first bridge below Hwy. 6	11.	450	--	8.0	--	--	>150,000
GSP108.4	At #6 Hwy. below junction with Eramosa River	19.	456	--	4.0	--	--	>15,000

Table 12 (Cont.)

Sample Pt.	Description	5-Day 5 BOD	Total Solids	Iron as Fe	Turbidity Units	Fluoride as F	Phenol ppb	M.F.Coliform per 100 ml
GSP 109.0	At #7 Hwy. bridge	6.9	338	--	4.0	--	--	3,900
GSP 111.2	At Park in Guelph	1.6	296	--	3.3	--	--	148
GSPE108.9	Eramosa R. below OAC STP Outfall	22.	500	--	4.0	--	--	8,000,000
GSPE109.9	Eramosa R. at bridge Victoria St. - Conc. 8	9.6	400	--	4.0	--	--	5,800,000
GSPE110.7	Eramosa R. at bridge below Guelph Reform. STP	2.3	338	--	1.7	--	--	60,000
GSPE114.7	Eramosa R. at bridge ½ mile below Eden Mills	1.2	330	--	1.0	--	--	42
				Canagagigue Creek				
GCG 125.6	Canagagigue Cr. at side rd. 1¼ miles S.E. of Elmira	122.	1896	--	20.0	--	4500	1,110
GCG 127.2	Canagagigue Cr. at #86 Hwy. at Elmira	5.2	458	--	2.1	--	--	19,300
GCG 128.6	Canagagigue Creek at Conc. rd. 1¼ miles north of Elmira	1.7	300	--	2.3	--	--	174

LATEST OWRC SAMPLING SURVEY OCTOBER 9, 1963

The sampling results obtained during the October 9 survey present a similar picture to the previous stream surveys.

Main Grand River

The 5-Day BOD in the river exceeded 4.0 ppm downstream from Kitchener, Brantford and Caledonia. The BOD was particularly high 92.0 ppm at Cainsville. This was attributed to the discharge of industrial wastes from Canada Glue Co. as a considerable amount of floating solids were noted below this effluent. Extremely degraded conditions were also noted in Sunfish Creek into which the wastes from Dunnville are pumped. (BOD - 285 ppm - 165 ppm)

The coliform counts exceeded the 2,400 organisms per 100 ml objective immediately downstream from each municipality, commencing at the Breslau bridge downstream from Waterloo and continuing in this fluctuating manner to the mouth at Lake Erie. As previously noted, the death rate of the coliforms was rapid in each case and satisfactory coliform densities were noted a short distance downstream from each sewage effluent. A particularly high coliform density was present at Cainsville due to the discharge of organic industrial wastes. In Sunfish Creek the coliform count was raised to 23,300,000 organisms per 100 ml by the discharge of raw domestic sewage and trade wastes.

From the source to a point immediately upstream from the Bridgeport Bridge the water quality was indicative of clean stream conditions.

In the lower reaches of the river from Dunnville to the mouth, particularly high concentrations of iron, fluoride, nitrogen and phosphorus are observed. Future sampling surveys will include a more complete picture of these chemical concentrations.

Conestoga River

The BOD concentration in the Conestoga River was satisfactory with the exception of one location GCO 160.8 at Charles St. bridge, West end of Arthur. This could be attributed to the discharge of domestic wastes from a storm sewer serving a portion of the village. The bacteriological counts exceeded 2,400 coliform organisms per 100 ml downstream from Arthur (2800), Drayton (57,000), St. Jacobs (9,000) but recovery was rapid.

Throughout most of its length the water quality was found to be satisfactory. The problem areas noted would be cleaned up when sewering of Arthur is completed, and when sewage treatment is provided in the Village of Drayton and the police village of St. Jacobs.

Speed and Eramosa Rivers

Particularly high BOD and coliform counts were determined in the Speed and Eramosa Rivers from Victoria St. in Guelph downstream to Beaverdale bridge south west of Hespeler. Degraded conditions in the stream are attributed to the discharge of industrial wastes from Guelph and Guelph Township and to inadequately treated domestic and trade wastes from Hespeler.

The need for concentrated engineering studies (along the Guelph Reach) is emphasized by this survey.

Nith River

The BOD concentrations in the Nith River were satisfactory with the exception of sampling location GN159.1 at the Elgin St. Bridge in Millbank 17 ppm. Little flow was present above this point and the stagnant water conditions contributed to the high BOD. High BOD concentrations and coliform densities were observed in the tributary creeks downstream from New Dundee, Wellesley and Baden.

Canagagigue Creek

The condition of Canagagigue Creek deserves particular notice. Industrial wastes from Naugatuck chemicals, domestic wastes from Elmira and industrial wastes from Gordon Young Limited in Woolwich Township have degraded the stream considerably. Installation of the municipal sewage treatment plant at Elmira presently under design will eliminate a portion of the problems but correction of the conditions in the township are also required. An excessive concentration of phenol (4500 ppb) was determined in the stream 1¼ miles below Elmira.

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This report is respectfully submitted.

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A. B. Redekopp

Approved by K. H. Sharpe
K. H. Sharpe, Director

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